CLAIMS

IN THE CLAIMS:

1. A multi-functional fibrous monolith structure comprising:

an inner ceramic phase;

an intermediate metal phase;

an outer ceramic phase.

2. The multi-functional fibrous monolith structure in Claim 1 wherein the intermediate metal phase is a interface strip deposited in a controlled array format to allow for strain measurement.

3. The multi-functional fibrous monolith structure in Claim 1 wherein the intermediate metal phase is a interface strip deposited in a controlled array format to allow for temperature measurement.

4. The multi-functional fibrous monolith structure in Claim 1 wherein the intermediate metal phase is a interface strip deposited in a controlled array format to allow the measurement of damage propagation.

5. The multi-functional fibrous monolith structure in Claim 1 wherein the intermediate metal phase is a interface strip deposited in a controlled array format to allow for temperature measurement and strain measurement.

6. The multi-functional fibrous monolith structure in Claim 1 wherein the intermediate metal phase comprises W and Re.

7. The multi-functional fibrous monolith structure in Claim 1 wherein the inner ceramic phase is ZrB_2, the intermediate metal phase is BN, and the outer ceramic phase is B_4C.

8. The multi-functional fibrous monolith structure in Claim 1 wherein the inner ceramic phase is Tungsten Carbide, the inner metal phase is a Tungsten-Iron-Nickel Alloy, and the outer ceramic phase is Tungsten Carbide.

9. The multi-functional fibrous monolith structure in Claim 1 incorporated in a drill bit insert capable of measuring strain during drilling operation.

10. The multi-functional fibrous monolith structure in Claim 1 incorporated in a machine tool capable of measuring strain.

11. The multi-functional fibrous monolith structure in Claim 1 incorporated in rocket nozzle capable of generating an electric current.

12. The multi-functional fibrous monolith structure in Claim 1 incorporated in a rocket nozzle capable of measuring temperature.

13. The multi-functional fibrous monolith structure in Claim 1 incorporated in a drill bit capable of measuring temperature and strain during drilling operation.

14. The multi-functional fibrous monolith structure in Claim 1 incorporated in a electronic casing to prevent neutron-related damage of electronics behind the casing.

15. A method of fabricating a piezoelectric/ electrostrictive structure having embedded electrodes comprising the steps of:

combining a electro-mechanically active ceramic material selected from a group consisting of lead zirconate titanate, lead lanthanum zirconate titanate, lead barium zirconate

titanate, lead stannate zirconate titanate, lead magnesium niobate, and mixtures thereof with a thermoplastic polymer binder and a polymer plasticizer to form a first composite blend;

combining a electrically conductive material with a thermoplastic polymer binder and a polymer plasticizer to form a second composite blend;

warm pressing the first composite blend to form a first feed rod having an axial core;

removing the axial core of the first feed rod to form a tubular feed rod having an inner diameter and an outer diameter;

warm pressing the second composite blend to form a second feed rod having outer diameter corresponding to the inner diameter of the tubular feed rod;

placing the second feed rod into the tubular feed rod to form a composite feed rod;

extruding the composite feed rod to form a reduced diameter composite filament;

consolidating multiple composite filaments to create a multi-filament feed rod;

extruding the multi-filament feed rod to produce a composite part having piezoelectric and electrostrictive properties.

16. The method of claim 1 wherein the electrically conductive material is a ceramic material.

17. The method of claim 1 wherein the electrically conductive material is a metal material.

18. The method of claim 1 wherein the electrically conductive material is a mixture consisting of a ceramic material and a metal material.

19. A composite part construction comprising:

a first phase comprising a ceramic material selected from a group consisting of lead zirconate titanate, lead lanthanum zirconate titanate, lead barium zirconate titanate, lead stannate zirconate titanate, and lead magnesium niobate consisting of piezoelectric and electrostrictive ceramics and mixtures thereof; and

a second phase comprising a material that is different than that used to form the first phase, the second phase being in contact with at least a portion of the first phase, wherein the composite part construction includes repeated structural units each comprising an ordered microstructure of first and second phases.

20. A fibrous monolithic structure comprised of

a core material and a shell material

wherein one of the materials comprises an electrically conductive material and the other material is an electrically insulating material.

21. A fibrous monolithic structure comprised of a core material and a shell material wherein only one of the materials is a piezoelectric material.

22. A fibrous monolithic structure comprised of a core material surrounded by a shell material in turn surrounded by a second shell material wherein the core and second shell materials comprise different electromotive potentials.

23. The structure of claim 22 including circuit means between the core and second shell materials.

24. The structure of claims 21 or 22 including means for measuring the electrical potential between the core material and shell material.